

2000



COUNCIL OF EUROPE CONSEIL DE L'EUROPE

Strasbourg, 26 April 2000
[Bern\T-PVS 2000\TpvS 17e_2000]

T-PVS (2000) 17

CONVENTION ON THE CONSERVATION OF EUROPEAN WILDLIFE
AND NATURAL HABITATS

Group of Experts on Conservation of Large Carnivores

Oslo, 22-24 June 2000

Action Plan for the conservation of the Iberian Lynx (*Lynx pardinus*) in Europe

*Document established by
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(Final draft, revised 01/0/3/2000)

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Funded by
WWF International - Mediterranean Program

The process behind the elaboration of the action plans

Each Action Plan was first elaborated by the author in early 1998. These first drafts included input and comments from many experts throughout Europe. In October 1998, governmental experts then discussed the Plans at a meeting organised by the Council of Europe in Slovakia, after which the authors incorporated the comments received.

The Plans were then reviewed by the Bern Convention Contracting Parties in December 1998 and again by the European Commission and EU governmental experts at a meeting of the Habitats Directive Scientific Committee in September 1999. All the comments received (and forwarded to the authors by the Commission via the Bern Convention Secretariat) were included in the final draft version presented at the Bern Convention Meeting of The Contracting Parties in December 1999. At this meeting, some governments advised that they still wished to comment on National Actions related to their respective countries and they were given until end February 2000 to send their comments to the Council of Europe.

The authors have made every effort to incorporate all the comments received into the final Action Plans and apologise unreservedly should any have slipped through the net. It is clear from the above that these Plans have been through an exhaustive, collaborative process and received a wide consensus, culminating in Recommendation No. 74 (Dec 1999) of the Bern Convention Contracting Parties, December 1999. Where differing figures have been given by various national experts (in particular as regards population numbers), every effort has been made to include both (or all) totals.

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May 2000

Species action plans

Large Carnivores in Europe

Europe once offered a wide range of natural habitats for its large carnivore species. Today, however, relict brown bear populations are dangerously small and highly fragmented in Southern, Central and Western Europe. The Iberian lynx has recently been labelled by the IUCN as the most critically endangered cat species world-wide. Wolf populations are under intense human pressure throughout most of their range. The Eurasian lynx has disappeared in much of Europe and even though wolverine numbers in Fennoscandia appear to have stabilised since it became protected, illegal hunting is still a constant threat.

Like many conservation issues, the future of Europe's large carnivores is dependent on cross-border co-operation between nations and, importantly, on managing their interaction with human activities. The challenge of conserving large carnivores is complex and must involve a wide range of stakeholders including land managers, local communities, governments, international Conventions and NGOs.

In response to this challenge, WWF International (the World Wide Fund for Nature), together with partner organisations and experts in 17 European countries, launched a Large Carnivore Initiative for Europe (LCIE) in June 1995. Since its inception the Initiative has grown rapidly with experts from 25 countries actively involved and many others expressing interest. The aim of the LCIE is to support and build on existing initiatives or projects across the continent, avoid duplication of effort and make the most efficient use of the available resources. One of the many activities that was identified as being of priority for the conservation of Europe's large carnivores was the elaboration of Pan-European Conservation Action Plans for the five species.

Species Action Plans for the Conservation of the Brown Bear, Wolf, Eurasian Lynx, Iberian Lynx and Wolverine

This Species Action Plan is one of a series of Pan-European Action plans elaborated for each of the five species at present dealt with under the LCIE (Brown Bear *Ursus arctos*, Wolf *Canis lupus*, Eurasian Lynx *Lynx lynx*, Iberian Lynx *Lynx pardinus* and Wolverine *Gulo gulo*). The plan should be seen as complementary with the other four plans and actions should be co-ordinated with those taken under the other plans since in many cases a natural guild of native predators is desirable.

The plans go beyond detailed analysis of local populations' needs and focus on the specific problem issue of managing the species throughout Europe, stressing the necessity for a continental approach and co-ordinated national efforts. It is hoped that one of the great values of these Plans will be that they generate a coherence to actions throughout the whole range of each given species.

These Plans are not management plans per se, but rather aim to form the basis for decisions at international level pointing at the importance of using populations as the management unit, which are often transnational. These Pan-European plans stress the need for national management plans to be drawn up in collaboration with neighbouring States where necessary. This is underlined in all of the Action Plans, and in order to facilitate this process a volume on Guidelines for developing Large Carnivore Management Plans (D. Hofer and C. Promberger 1998) has just been produced by the LCIE.

These Plans serve as an important communication tools and their recommendations should be used to influence players in the conservation sphere at local, national, and international levels. They also provide a baseline record against which to measure change in future years as well as a common framework and focus of action for a wide range of players.

The responsibility for the elaboration of the plans was assigned to teams working under some of the top European international experts for each species. During the preparation of these action plans the authors consulted a wide spectrum of sources including management authorities, researchers, NGOs and the literature.

This open process will culminate in a workshop for governmental experts in Slovakia in October 1998, organised by the Council of Europe (Bern Convention Secretariat) specifically to discuss the five Action Plans. After this workshop, the revised final versions of the Plans will be presented to the Bern Convention for endorsement.

Endorsement

The Council of Europe document "Guidelines for Action Plans for Animal Species" [*T-PVS (ACPLANS) (97) 8*] underlines the importance of producing Action Plans for large carnivores at a Pan-European level: "It also makes good ecological sense to choose species that serve as protective "umbrellas" for other species. Such a single species effort avoids many bureaucracies and provides many "inclusive benefits". Umbrella species are species whose own area requirements provide some index on the area requirements of the ecological systems that support them. Top carnivores or other large-bodied, long-lived, slowly reproducing species at the top of their ecosystems food-chain are good examples...." The document states that "The Council of Europe through its Committee of Ministers or the Bern Convention's Standing Committee are in excellent position for endorsing such Plans."

Implementation

It is very important that these Action plans once "endorsed" are acted upon. These Action Plans should guide national authorities in the elaboration of National Plans and the implementation of these plans must be carried out by professional teams that involve a wide range of appropriate interest groups. The plans themselves can act as important fund raising tools to help spark off the implementation. In countries where more than one of the large carnivore species is present the elaboration of National Action Plans (as recommended by these Pan-European Action Plans) for each species should be in harmony with one another.

Common Themes

All five Action Plans have clearly identified a number of important common themes, which include the following fundamental guiding principles:

- there is a need to concentrate conservation efforts at the population level, which often requires cross-border co-operation;
- the principle of management of large carnivore through a system of zoning including core areas, buffer zones and corridors;
- where re-colonisation of areas by large carnivores is desirable, the following principles should be applied:
 - priority should be firstly support natural re-colonisation,
 - secondly to work on the augmentation on non-viable populations,
 - thirdly to release animals into areas in order to join up non-viable populations, and
 - finally, to carry out releases into new areas;

- it would be highly desirable that each country sets up a specific body that is responsible for large carnivore management issues, and who would be charged with the preparation of national management plans (A single body that is responsible for all large carnivore species is desirable);
- wherever compensation systems are in place, these should be tied to prevention incentives;
- with regard to identified "problem" animals, which create local damage, emphasis should be given to maintaining populations and not by concentrating on individuals (apart from rare exceptions);
- in-depth and scientific human attitude studies (including work on conflict resolution) have to be initiated.

The points made above just give a brief indication of some of the more important common themes or principles that are shared by all five action plans that have been elaborated as part of the series

Conclusion

Finally we would like to thank the authors, all those who have provided data and comments and the Council of Europe for all the hard work and support that has been put into this. We would also like to thank WWF Netherlands, Sweden, Norway, Mediterranean Programme and the Council of Europe for providing the funding for the elaboration of the Plans. We hope that these plans will form the basis for collaborative pan-European conservation work for these species over the next ten years, and that the success can be an example to other Initiatives.

Magnus Sylven (WWF International, Chair, LCCG)

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Executive summary

Amongst the European large carnivores, the Iberian lynx is the only endemic species. Hence, Europe must ensure the preservation of the lynx to keep coherence when claiming similar efforts in other parts of the world. Another remarkable feature of the Iberian lynx is its qualification as the most endangered felid species in the world, given its low total population size, its highly fragmented distribution, and its declining population trend and strong range contraction during the last century. These characteristics make the conservation strategy for the Iberian lynx diametrically opposed to that of other large carnivores, such as the Eurasian lynx or the wolf, that tend to expand their distribution limits in many European countries. Therefore, the main goal of the present Action Plan is achieving long-term viability for the few existing populations of the Iberian lynx. The Plan offers a discussion of conservation problems and contains guidelines to solve them, but it is not a management plan itself.

The speed at which the Iberian lynx heads for extinction is so fast that a drastic intervention of the competent Environmental Administrations is needed in many fields to fulfill the mandate of conservation laws. Measures have to be taken to preserve and recover a landscape that mimics the Mediterranean ecosystem resulting from millennia of man-forest interaction, which presumably has benefited rabbits, a crucial resource for lynx survival. When extensive habitat recovery is difficult or impossible between populations, linear corridors are needed to favour interpopulation dispersal. The destructive ability of modern human activities and developments on the sensitive natural areas of southern Iberia must be limited. Economic support should be provided to land uses favouring the recovery of rabbit populations. Lynx deaths due to direct or indirect human actions must stop immediately, and levels of natural mortality should be reduced by improving habitat quality (i.e. survival) in lynx areas. Although it is believed that *in situ* measures should prevail among conservation efforts, some knowledge is needed about *ex situ* initiatives, including an experimental captive breeding program, and other techniques aimed at lynx reintroduction or restocking which could be needed in the next future. Many practical questions remain unanswered because of incomplete information on ecological and behavioural aspects of the lynx biology. Therefore, research programs should cover current gaps in our knowledge. Special attention must be paid to improving methods for monitoring lynx presence and abundance, which allow assessment of the efficiency of conservation measures. In practice, most of the actions listed above generate some conflicts with ongoing activities and, therefore, need a strong political and legal support. In particular, many areas require some kind of legal protection.

The conservation of the Iberian lynx requires the participation of a number of collectives, and putting the measures proposed in this Plan into practice depends, in the end, on individual decisions and on the personal commitment of many people with the philosophy of this document. In this regard, some work can be done through economic incentives, but the stress should be on clear information and education. The Iberian lynx only lives in two countries, and co-operation between them is clearly required to preserve international populations, justifying and giving meaning to the Pan-European framework of the Large Carnivore Initiative. A similar co-ordination is needed between regions in Spain, that hold the responsibility of lynx conservation, and between branches of the same administration.

1. Introduction

Nowadays the Iberian lynx (*Lynx pardinus*) is the most threatened carnivore species in Europe and one of the most endangered mammal species in the world. These attributes have quickly emerged in recent times after gaining a more precise knowledge on the species taxonomy, status, and distribution.

Although lynx living in Iberia were first described as a distinct species as early as in the first quarter of the XIXth century, a lasting controversy has taken place since some influential taxonomists regarded them just as the small-sized, southwestern subspecies of the Eurasian lynx. Besides, some of the authors that defended the Iberian lynx specific identity included under the same species most (or all) of the spotted lynx populations living in southeastern Europe and the Caucasus. During the second half of the XXth century accumulated paleontological and morphological evidence strongly suggested that the Iberian lynx and the Eurasian Lynx (*Lynx lynx*) were two different species. A few years ago this hypothesis received support from molecular analyses, that established an earlier evolutive divergence between the Eurasian and the Iberian lynx than between the Eurasian and the Canada lynx (*Lynx canadensis*). In consequence, only recently the Iberian lynx taxonomic position as an independent species has been widely accepted. Similarly, until the early 1990's details on Iberian lynx distribution, numbers, and population trends were either very roughly estimated or entirely unknown.

Undoubtedly as a result of past uncertainties, the conservation of the Iberian lynx has not been paid the proper attention from both national and international conservation agencies. However, today it is acknowledged that *Lynx pardinus* has an endemic distribution limited to the Iberian Peninsula. Therefore the Iberian lynx and the European mink (*Mustela lutreola*) are the only endemic carnivore species in Europe. It is also a fact that the Iberian lynx range has contracted at an alarming speed during at least the last 150 years, and that overall population size has decreased even faster to reach the current estimated numbers, well below one thousand individuals. Such information has generated serious worries among conservationists all over the world, but obviously the concern is highest in the EU countries, particularly Spain and Portugal. At the political level, the competent European authorities can not demand the preservation of the biodiversity in the less developed countries of the world allowing at the same time that the first extinction of a felid species in many centuries will be a European endemic.

2. Background information

2.1. Limitations of the available information

The Iberian lynx is a poorly known species. Little effort has been devoted to understand its biology, ecology and behaviour, perhaps due to the species scarcity and limited distribution. Until 1980 the only published information on the Iberian lynx primarily came from the study of museum specimens, as well as the compilation of observations among people living in rural areas. This sometimes heterogeneous (from a scientific standpoint) approach has been partly corrected during the last two decades. However, most modern studies have been carried out on the small lynx population living in the Doñana National Park and surroundings, a region claimed to be atypical in terms of habitat features and level of protection compared with the prevailing conditions across most of the species' range. Therefore, one must bear in mind that

the Iberian Lynx Action Plan will be necessarily based on partial and insufficient knowledge, mostly obtained from a single population during a relatively short period. Nevertheless, following the Biodiversity Convention recommendations, the lack of information should not be used as an excuse for conservation passiveness.

2.2. Description of the species

The Iberian lynx has the regular appearance of the other members of the genus *Lynx*. Its body size compares to that of the American species, i.e. the Canada lynx and the bobcat (*Lynx rufus*), but it is about half the size of the Eurasian lynx. The species shows a relatively small head, long legs, and a very short tail with black tip. Its face is short and flat, flanked by a characteristic 'beard', especially conspicuous in the adults, and its triangular ears end in black tufts. Feet are broad, and toes hide retractile claws. The dominant background colour of the Iberian lynx coat is tawny, mottled with dark spots very variable in size, shape, and colour intensity. Efforts have been made to categorise this variability into four main pelt patterns, according to the configuration, size, and sharpness of the spots. Adult males weigh between 11 and 15 kg (mean 12.8), and adult females between 8 and 10 kg (mean 9.3). One-year-old lynx weigh about 7 kg regardless sex. Some circumstantial evidence might indicate variation in body size between different lynx populations (for instance, breeding females weighing 7 kg have been reported in Montes de Toledo).

2.3. Distribution and population numbers

2.3.1. The status of the Iberian lynx in Spain

Unfortunately a reliable standard method to detect the presence of the Iberian lynx has not been developed yet, mostly due to its solitary behaviour, nocturnal or crepuscular habits, low density of its populations and difficulty of being observed. With the only exception of the sandy Doñana area in southwestern Spain, where track counts have proved to be useful, it is hard to draw a distribution map on the basis of lynx signs. Distribution limits are largely based on plots of locations where sightings or deaths have been reported by gamekeepers, hunters, naturalists, and other people who are usually active in wild areas. Whereas some of these sources are extremely valuable, instances of wrong reports (e.g. mistaking lynx for wildcats, domestic cats, genets and other animals) are quite common. Sometimes searches for lynx scats have been used outside the Doñana area, but some experience is required for scat identification, or it is necessary a validation by using biochemical or molecular techniques, which are still being developed. On the other hand, searching for signs such as scats or tracks in areas with low density lynx populations hardly produces any finding, and in these cases compiling reports is the only alternative left. As the appraisal of oral reports is largely subjective and the ability to recognise lynx signs varies between surveyors, the results of inventories made by different teams can hardly be compared. More objective methods including mewing playbacks and scent stations associated to soft substrates where tracks can be printed, or to photographic devices, have also been attempted with scant success. In summary, current methods to monitor trends in the lynx range often provide very rough data that are loaded with subjectivity and difficult to compare with the results of previous surveys.

2.3.1.1. *The 1988 survey*

In the late 1980's a study was carried out aimed at delineating in detail the distribution, and estimating regional variations in the abundance, of the Iberian lynx. This survey was based on a combination of postal enquiries and extensive personal interviews in the field. Information dated in the period 1978-1988 was first subjectively filtered for quality (i.e. only reliable reports were considered), and then areas with both stable and transient populations were identified by using objective criteria, e.g. the pattern of spatial and temporal aggregation of reports. Spatial differences in density were estimated in a similar way. The major value of this study was to be the first one, and so far the only one, that used a single method (executed by a few people) and a homogeneous data treatment to estimate distribution and abundance on almost all the lynx range. Its main limitation as a tool for detection of population trends is the difficulty to repeat it, as the ability to assess oral reports is expected to change with the researchers and the circumstances.

The main results of this study were that

1. lynx presence could only be confirmed in the southwestern quarter of the Iberian Peninsula (i.e. populations reported in other areas might had gone extinct or been close to extinction ten years ago),
2. with the exception of the flat, coastal Doñana area, the species was largely confined to broken terrain below 1300 m, preferably covered with a mixture of Mediterranean scrubland and open grassland, where intensive land uses of any kind were absent,
3. range size was very small: some 11700 km² of breeding areas plus 3900 km² of areas only transitorily used,
4. the range was extremely fragmented in 48 breeding areas of dissimilar size,
5. relatively high lynx densities were only assigned to 17% of the breeding range,
6. the estimated total Spanish population was about 880-1150 individuals, excluding kittens, which was equivalent to about 350 adult females,
7. assuming that individual dispersing lynx easily reach any breeding area within 30 km of their natal area, but rarely emigrate to further breeding areas, all 48 nuclei could be grouped in nine populations with high chances to be genetically isolated,
8. these nine hypothetical populations were located as follows (Figure 1):
 - in the northern edge of the range, three unconnected populations (Sierra de Gata, Sierra de Gredos, Alto Alberche; together 13% of the range, 8% of the total population size) occupy the Sistema Central, an east-west oriented mountain range in central Iberia,
 - one population in Sierra de San Pedro (5% range, 4% population size),
 - one large central population, including the natural regions of Montes de Toledo, Villuercas, Siberia Extremeña, Montes del Guadiana, Valle de Alcudia, and the large block of Eastern Sierra Morena (62% range, 71% population size),
 - two populations in Central and Western Sierra Morena (together 12% range, 10% population size),
 - one population in the Sierras Subbéticas (4% range, 2% population size), and
 - the Doñana population (4% range, 4% population size).

2.3.1.2. *More recent information*

In Spain the Comunidades Autónomas (i.e. the regional Administration, henceforth abbreviated CA), are responsible for the conservation of the Iberian lynx and other protected species. The governments of Castilla-La Mancha, Castilla y León, Extremadura, and Madrid have entrusted field inventories to different teams in order to update the lynx status in their respective regions after 1995. The results of these studies (made mainly on the base of field inquiries) suggest either that the estimates made in the 1988 survey were too optimistic or that population size has decreased remarkably during the last ten years. A summary of the results follows.

Andalucía

Although a new survey has not been attempted in Andalucía, lynx populations have been monitored, but not intensively. Sporadic reports have been collected throughout Sierra Morena, as well as Subbéticas and Andévalo natural regions. Systematic monitoring is made in the sandy Doñana area. Very roughly, about 300-400 lynx are reckoned to live distributed among these populations. This represents about 60% of numbers estimated ten years ago.

Castilla-La Mancha

In 1996 the estimated number of lynx living in this CA was between 90 and 120 individuals, less than one third of those calculated in the 1988 survey. The species has been found in the eastern end of Montes de Toledo, Montes del Guadiana, northern ranges of eastern Sierra Morena, and Sierra del Relumbrar-Guadalupe area.

Castilla y León

New relevant information has not been found in this region. The Iberian lynx seems to be very rare and at best confined to some localities in the south of the Ávila and Salamanca provinces. Guesses about population size range from zero (doubtful presence) to 40 individuals. In 1988 about 30 individuals were estimated.

Extremadura

Estimated numbers have decreased slightly during the 1990's. Lynx can still be found in the Northwest (Sierra de Gata and Granadilla), eastern mountains (Villuercas, Cijara, Monfragüe), and Sierra de San Pedro in the West. The region may harbour between 75 and 110 lynx, figures that compare to the about 125 individuals reported in the 1988 survey.

Madrid

About a dozen recent reliable reports have been gathered in the Alto Alberche area, on the western border of this CA. Population size is probably not higher than 10 lynx within the region boundaries, as it was in 1988.

2.3.2. The status of the Iberian lynx in Portugal

A modern survey on the status of the Iberian lynx in Portugal was undertaken in 1994. Field methods used to assess lynx distribution and numbers were largely the same as in the Spanish 1988 survey. Although some reports referred to dead animals (testable), the most common kind of information (sightings) was obtained indirectly from interviews in the field. The reliability of every report was checked by the researchers, and all doubtful information excluded. Lynx seem to persist in five populations, that at most could measure 2400 km² and harbour a total population of 40-53 individuals. Three areas (Serra da Malcata, Serra de São Mamede and Guadiana Valley) are western extensions of the Sierra de Gata, Sierra de San Pedro, and Western Sierra

Morena populations, respectively, across the Spanish border. All these populations have declined in the last decades and probably do not contain more than 10 individuals each. Occasional reports point to a possible communication between the international populations of Gata-Malcata and San Pedro-São Mamede, at the Portuguese side of the border. The most important Portuguese lynx region is Algarve-Odemira, in the southern end of the country. There, reports are distributed in four relatively large and three small nuclei that sum up some 940 km². Numbers have declined and no more than 25 animals are believed to live there at low density. A remnant population seems to persist in southwestern Portugal associated to the Sado river basin, probably connected through dispersing animals with the Algarve-Odemira population, totalling some 1300 km² and up to 30 lynx (Table 1).

2.3.3. General status and population trends

It is difficult to know where and how many lynx there are. Perhaps the main obstacle in designing a conservation plan comes from the methodological limitations to monitoring range and population trends. However it is clear that lynx declined quickly throughout its range, and that this has been a long-lasting trend. One century ago the species was very common in southern Iberia, and was still present in some northern localities. Fifty years before now it had become virtually extinct in the north, and seemed to be scarce or absent in some southern regions. The best known decline, which involved an 80% range loss between 1960 and 1990, illustrates the speed at which the species heads for extinction.

It is a fact that lynx live, at best, in nine isolated populations (Figure 1). Furthermore most of these populations consist of far less than 100 individuals (Table 1) and consequently they are exposed to a very high risk of extinction, even in the short-term. Only the Montes de Toledo-Eastern Sierra Morena population contains a few hundred lynx but, after a recent remarkable decline in Western Montes de Toledo, the largest population might had been divided into two separate pieces. In addition, it is also clear that each population is made of smaller, spatially distinct nuclei that probably keep in touch through dispersal. Some of these subpopulations may work as sinks (i.e., mortality is higher than productivity) and their persistence may depend critically on immigration from source subpopulations, where there is a net positive population growth rate. That is, lynx dynamics likely fit those of metapopulations.

2.4. Life history

2.4.1. Food requirements

Among available prey, Iberian lynx strongly select, and depend upon, European rabbits (*Oryctolagus cuniculus*), i.e. they are feeding specialists. Rabbits consistently account for 80-100% of the consumed biomass in the lynx diet. Such a high percentage varies little regardless geographical, seasonal and annual variations. The energetic daily needs of one adult individual have been estimated as 600-1000 kcal, which is very close to the amount of energy one adult rabbit contains. One breeding female with two kittens may need up to three rabbits per day. All these calculations lead to the tentative estimate of 1 rabbit/ha as the minimum rabbit density that might allow lynx breeding.

Other vertebrates, including rodents, European hare (*Lepus granatensis*), red-legged partridge (*Alectoris rufa*), ducks, and geese (*Anser anser*) can be regularly killed and eaten in some areas and/or seasons, but they always contribute little to the lynx diet. Several ungulate species can occasionally be taken, especially in winter. Ungulate prey include juvenile red (*Cervus elaphus*) and fallow deer (*Dama dama*), and mouflon (*Ovis musimon*). Roe deer (*Capreolus capreolus*) has not been reported as a prey, perhaps just because it is absent in the areas where the lynx diet has been studied.

2.4.2. Habitat requirements

The Iberian lynx is also a habitat specialist. Among a long list of habitat variables that were examined, the elimination of Mediterranean scrubland¹ was the most important factor explaining the species' strong range decline between 1960 and 1990.

At the population scale, surveys based on signs and radiotracking data show that scrubland is clearly and positively selected by lynx. Such selection has been interpreted in terms of the need of shelter for bedding and breeding provided by the scrubland. Rabbits are often abundant in the scrubland, but they need small open areas (pastures, cereal fields and so on) interspersed within it. Lynx have disappeared from many areas covered with dense scrubland, mainly in the north but also in some southern places of the Iberian Peninsula. These extinctions are likely to be associated with low density (or absence) of rabbits. Thus, shrub protective cover alone is not enough to explain lynx preference for scrubland and, with our present knowledge, the species optimal habitat could be defined as a patchy mixture of scrubland and openings where the interface length is maximized.

In Doñana area, where some data on reproduction are gathered, hollow trees are used as breeding dens, but in other areas where this resource is very rare, other structures such as rock caves, boulder piles or ground dens can be used for the same purpose. A breeding female may use several auxiliary dens, and kittens are moved from one to another. Females can also hide their young offspring in very dense scrubland or already enlarged (e.g. by fox or badger) rabbit warrens.

2.4.3. Activity and home range

Activity patterns show noteworthy individual variability. Although lynx can move at any time of day, activity peaks in the twilight, especially at sunset. Diurnal activity takes place mainly in winter. It has been hinted that patterns of activity might follow those of rabbits.

Adult lynx live usually in stable home ranges that measure between 4 and 20 km². In Doñana, the average female home range size is 12.6 km² where rabbit density is relatively low, and 5.3 km² where it is high. Values for males are 16.9 km² and 10.3 km², respectively. The home range size of one adult female in Sierra Morena was 5.4 km².

2.4.4. Social organisation and density

As many other cat species, lynx maintain a solitary way of life. Males do not help to raise the kittens and, as a rule, they meet females only during the mating season. Adults defend their home ranges as territories against intruders of the same sex, especially in areas where rabbits are scarce. Male territories encompass one or more female territories. Females only breed when they hold a territory. Probably, transient males are excluded by resident males from female territories during the mating season, although it is unknown how efficient territory holders are in preventing occasional mating by intruders. The Doñana population is close to its carrying capacity and the total number of suitable territories is low. Consequently, intrasexual aggressive interactions often occur in order to compete for a territory, leading sometimes to the death of the one of the lynx involved. In Doñana an increase in sexual competition associated

¹ In this document, we use the terms "Mediterranean scrubland" and "Mediterranean forest" for designing the vegetation characteristic of the Mediterranean-Iberoatlantic phyto-geographic super-province, which occupies most of the western half of the Iberian peninsula. The outstanding components are holm oaks, cork oaks and gall oak (*Quercus spp.*) among the trees, *Phillyrea spp.*, *Arbutus unedo*, *Pistacia lentiscus*, and *Viburnum tinus* among the shrubs, and some *Cistaceae*, *Erica spp.*, *Rosmarinus spp.*, *Rhamnus spp.*, among the scrubs. Patches of wild olive trees (*Olea europaea var. Silvestris*), wild pear trees (*Pyrus silvestris*), *Juniperus spp.*, or other species can be found, whereas in elevated and moist localities patches of *Fraxinus spp.* or even *Alnus glutinosa* are also frequent.

with high population density may explain why the mating system is closer to monogamy than to the typical polygynic system of other solitary felids. Given a high intruder rate, males might choose to concentrate their effort in defending his exclusive access to a single female.

Habitat quality, especially the rabbit abundance component, influences mean home range size, the social system and, as a result, lynx density. In the best known habitats of northern Doñana, lynx density is as high as 0.8 adults/km², whereas in other parts of this area with only moderate rabbit densities, it ranges between 0.1 and 0.2 adults/km². The estimated absolute density across most of the lynx range fluctuates around 0.08 adults/km², a value one order of magnitude lower than the maximum density observed in Doñana.

2.4.5. Reproduction

The reproductive biology of the Iberian lynx is not well known yet. There are indications that oestrus peaks in January and most litters are born between March and April. However, when females do not find a mate or not become pregnant, when gestation is interrupted, or when litters are lost at an early stage, females may enter oestrus again, so that births can happen almost at any time of year. Litter size at birth ranges between two and four kittens, the mode being three. Indirect evidences suggest that litters of five would be possible. In most cases only two offspring survive weaning. Kittens stay in the natal den between two and four weeks. Afterwards, the female moves them among several auxiliary dens. At four weeks old they start to eat some prey brought by the mother to the den. At the age of four months cubs go along with their mother and develop hunting skills. When they are seven months old, they still spend 60% of their time with the adult female. After the first 10-11 months of age, young live independently within the natal territory.

Available information about the age of first reproduction is scarce. Probably females are able to reproduce in their second year, but in Doñana they rarely do it before the third year, possibly because of high competition for breeding territories. Reproduction does not occur every year, even in the best habitats like northern Doñana, where the average reproductive rate is 0.8 litters per female and year. The proportion of females that breed in a population is most likely influenced by habitat quality.

2.4.6. Dispersal

Most juvenile lynx definitively abandon the natal area when they are between 8 and 23 months old. Males disperse before and farther than females. Some females may inherit the maternal territory, or a part of it, or may settle down in a contiguous territory. Juvenile males use not to stay in or close the natal home range. Dispersal in the Doñana population lasts between a few weeks and 18 months. New territories are found by dispersing lynx at distances that range between 3 and 30 km from the maternal territory (mean 16 km). Dispersing individuals can use habitats of lower quality (less cover and less rabbits) than those where they come from and those where they settle down, rather as a result of avoiding areas occupied by resident lynx than a real avoidance of optimal habitats. During the dispersal process, lynx usually remain within habitats that offer natural cover, and rarely enter more than 2 km into open land. However, they proved able to cross tracts of uncovered habitats up to 5 km wide if there are one or more linear elements in the landscape (e.g. streams, hedges, roadside vegetation) that can be used as a guide to reach the edge of another suitable habitat patch at the other end.

Mortality rates are very high during the dispersal phase. In the Doñana area only 12 out of 35 monitored animals survived and established themselves in a new home range. In Sierra Morena most lynx died during dispersal too.

2.4.7. Lifespan

The oldest lynx living in the wild was known to have reached at least 13 years old. Most likely, individuals older than 10 years are not able to breed.

2.4.8. Interactions with other carnivores

Adult lynx often kill other carnivore species of smaller size they found within their home ranges, including dog, domestic cat, red fox (*Vulpes vulpes*), common genet (*Genetta genetta*), Egyptian mongoose (*Herpestes ichneumon*), and otter (*Lutra lutra*). As a result of intraguild predation, small carnivores make a low use of lynx home ranges, and areas inhabited by Iberian lynx sustain lower densities of other carnivore species than areas without lynx. Low carnivore density is reflected in some relaxation of predation pressure that, in turn, may produce a relatively high prey density. So, through mesopredator suppression, lynx lower competition and enhance rabbit density inside their ranges.

2.5. Lynx and humans

In the past, humans regarded the Iberian lynx either as a valuable hunting trophy or as a vermin, put together with other predators in the bag of competitors for small game. Reports of direct attacks to livestock (chiefly goats and lambs) have always been scarce, and no attack has ever involved people. In spite of the protected legal status of the species since 1973 (Spain) and 1974 (Portugal), levels of illegal persecution have presumably decreased very slowly during the last 25 years. Nowadays, it seems that lynx are rarely shot by poachers, mainly because of its own scarcity, and because at the same time they are no longer perceived as an important source of damages to the game business. Nevertheless, in many estates where small game is a significant source of income several non-selective predator control methods (snares, traps, poisoning), said to be targeted at other carnivore species, are sometimes allowed and legally (often illegally) used. As a result, lynx and other protected species are systematically killed too.

Although the landowners general attitude toward the species as a predator might be close to neutrality, it tends to be negative when viewing lynx as a protected species. In protected areas even small restrictions applied to some land uses, and exceptionally to property rights, are never welcomed, and usually magnified as serious economic losses, by landowners. Since lynx conservation is sometimes one of the implicit reasons for reserve establishment, some owners blame lynx for their decreased profit. On the other hand, the same argument indicates the species potential as an appealing symbol for the conservation of the best preserved Mediterranean ecosystems, especially among urban people. The beauty and critical status of the Iberian lynx are favourable features to enhance social pride in taking care of the species and its habitat. Such a positive, but somewhat vague, social disposition has not yet triggered a more efficient political and administrative commitment to lynx conservation.

2.6. Threats, limiting factors and obstacles to conservation

Among the threats and limiting factors that affect lynx populations, it may be useful to distinguish deterministic factors, which have caused, and still do, a strong numerical decrease, from stochastic factors, whose effects are especially amplified (through extinction vortices) in small populations. It is important to be aware that most small lynx populations have been put under the serious risks of stochasticity as a consequence of the former enduring action of deterministic factors.

2.6.1. Deterministic factors

2.6.1.1. Habitat alteration

The Iberian Peninsula has been inhabited by shepherds and farmers for at least eight thousand years. Assuming that grassland openings were not very common within pristine forests, early settlers could have indirectly favoured lynx by firing and cutting the original Mediterranean forest, and by ploughing the resultant open ground, because these transformed habitats might have sustained denser rabbit populations. It must be emphasised that such perturbations improved lynx habitat only when enough forest was left in the landscape. Moreover, habitat improvement is probably better when several small open patches are interspersed within the forest matrix than when a single tract of habitat of the same size is altered. This is the reason why traditional agricultural practices in the mountains (e.g. small clearings to obtain firewood or charcoal, small orchards, extensive livestocking) have benefited lynx, and why the features of modern intensive agriculture (e.g. large developments for irrigation systems, lower diversification of agricultural landscapes as constrained by mechanisation) are detrimental for the species (see below). At the opposite extreme, the increase in scrub density following the abandonment of farming practices lowers habitat suitability for rabbits and lynx.

Large average size of estates is an outstanding feature of land property in southern Spain. That is, a large area is owned by a few people. This may lower diversity in management styles. At present, hunting is the main source of income in these areas. During the last decades, economic profitability has caused deep changes in hunting management, namely a higher concern for big game to the detriment of small game, and a switch from extensive to intensive practices in big game. Artificial food supply and fencing result in very high densities of wild ungulate species (chiefly red deer) and vegetation degradation by overgrazing, overbrowsing, and trampling. In order to provide additional grassland to dense deer populations, further forest and scrubland is thinned or removed, whereas woody plants in the remaining forest tracts are allowed to grow and close up as ungulate refuges. Rabbit populations dwindle steadily under these conditions. Moreover, dense scrubland is also extremely beneficial to wild boar (*Sus scrofa*) and other efficient predators of rabbit litters. Livestocking is an important alternative land use in the southern Iberian mountains. The detrimental effects of dense game populations on vegetation apply to artificially-maintained high densities of livestock.

Varied edge effects arise from human leisure activities in lynx areas. Urbanisation (both legal and illegal) is still growing and threatening some of the best lynx populations. The vicinity of human dwellings, with its halo of rubbish, poachers, noises, feral pets, and so on, has been found to be strongly avoided by Iberian lynx. There are some cases of new housing projects in the heart of critical areas for the lynx as, for instance, the Jándula River near Andújar (Jaén Province, Spain). Strong perturbations also come from some increasingly popular outdoor activities, such as four-wheel and motorbike driving, and the so called 'adventure sports', which are facilitated by the improvement of the road and path networks in what a few years ago were relatively wild and remote areas.

There are already altered landscapes that are not suitable for lynx reproduction but allow lynx dispersal. Further modifications in these habitats may hinder lynx movements, increase the mortality of dispersing individuals, and reduce or prevent emigration between nearby lynx populations. The two major sources of habitat corridor alteration are 1) steady degeneration of riparian vegetation due to several kinds of land use changes, and 2) removal of hedges and linear vegetation boundaries between agricultural fields, promoted by land concentration plans that aim at a more intensive farming. The rapid development of transport infrastructures (e.g. roads, railways, channels) favours human access to wild areas, reduces the permeability of the landscape to lynx movements, and increases lynx mortality (e.g. traffic casualties, drowning).

2.6.1.2. Habitat removal

Whereas openings in a matrix of forest can support more lynx than a dense, homogeneous forest, clearance progression through centuries has often ended in an inverted landscape, with a few forest patches within an agricultural matrix. Lynx can not live in this kind of landscape, even when some rabbits are retained. In the Iberian Peninsula extensive extirpation of woody plants for farming went on clearly until the 1960s, when human emigration from rural to urban areas became a social wave, and scrubland clearance started to level off. Today, this trend might have reversed, as the European Union produces a surplus of agricultural products, and policies tend to promote farming abandonment and afforestation programs. There are, however, exceptions linked to intensive, economically profitable crops. For instance, in the surroundings of the Doñana National Park, the scant patches of scrubland left continue to be removed for growing vegetables under plastic shelter.

A large proportion of the potential lynx habitat in the Iberian Peninsula has been allocated to forestry. During the second half of this century, original forest was extensively replaced with conifer and eucalyptus plantations for timber and wood pulp production. The shrub layer is virtually absent in eucalyptus stands and periodically removed in pine stands. Rabbits are very scarce or absent within such plantations. Whereas removal for farming has decreased, natural vegetation is still destroyed for forestry. Currently, this trend is partially related to the misinterpretation, and wrong application, of a European afforestation program, whose main aim is to take advantage of agriculture withdrawal to improve environmental quality and to increase biodiversity. This plan finances the conversion of old fields into forested areas. However, many scrubland patches are classified as improducible fields, then removed and replaced by a new plantation. Rounding off the perversion of the afforestation program, planted tree species are often conifers (mainly pines) or other quickly growing species, which do not represent the best choice to recover the original Mediterranean forest. These aberrant practices concern many sites across the Iberian Peninsula, for example the removal of natural vegetation (mainly *Arbutus unedo*) in large areas of Algarve (Portugal).

Every summer, Mediterranean forest and scrubland is destroyed in large areas by fires, habitually lit on purpose. Forest fires reflect economic interests or conflicts related to forestry, livestocking, hunting, and urbanization. When one of this new land uses is not allowed, planners often opt for planting burnt areas with conifers arguing the extremely low regeneration of natural forest and the urgent need for soil protection. Only since 1996 have this kind of fires been considered as a grave ecological crime by the Spanish law.

Human developments generally have a local impact, but the chances for the habitat to be recovered after this kind of extirpation are minimal. In the Iberian mountains, valley bottoms that have always been cultivated often display the optimal mixture of shrub cover and grassland. Frequently, these areas have been submerged under water by reservoirs built for hydroelectric power, irrigation, or regulation. In several cases the flooded area has been very large, and the amount of lost habitat comparable with that of agricultural or forestry transformations. Some lynx populations are currently threatened by dam construction, for instance the Breña II reservoir in Córdoba Province (Spain), and Odelouca dam in Algarve (Portugal). Other activities, as openpit mining and gravel extraction, and developments, as energy plants or large factories placed far away from populated areas, also imply complete removal of lynx habitat.

2.6.1.3. Prey scarcity

In the Iberian Peninsula rabbit populations have experienced a pronounced decline during the last forty years. Unfortunately there are very few records of this striking decrease but, for instance, in the Doñana National Park current rabbit numbers are estimated to be less than 5% of the species population levels in the 1950s. Rabbits are now relatively scarce everywhere, and in marginal range, where climate or soil conditions are not optimal, they have disappeared. The rabbit collapse has been ultimately attributed to two main causes: changes in land use and disease. It is believed that these factors originally weakened rabbit populations, making them more vulnerable to several proximate factors including elevated hunting pressure and high predation levels by generalist species.

In the late 1950's myxomatosis entered the Iberian Peninsula and quickly spread throughout, decimating rabbit populations that since then have remained well below the 5% of former levels of abundance. Myxomatosis still causes massive rabbit deaths every summer, although the proportion of rabbit losses seems to recede today compared with estimated figures in early years. This trend has been related to adjustments in the dynamic equilibrium between mutation in the myxoma virus and the rabbit immune response.

In the late 1980's, a new viral disease called Rabbit Haemorrhagic Disease (RHD) arrived to the Iberian Peninsula. Again the disease was detected in most rabbit populations within three years, and numbers decreased catastrophically almost everywhere. For example, in Doñana reductions of about 80% were measured, and in some localities of Montes de Toledo RHD lowered abundance more than 90%. Although in some places signs of recovery have been detected, rabbits have vanished from large areas and are still on the verge of extinction in many others.

Changes in land uses caused landscapes to depart from an optimal fine mosaic of shrub cover and openings. The ways in which these departures affect rabbit abundance have been discussed above. It can be added to that argumentation that myxomatosis might have triggered a vicious circle: profit losses in small game hunting due to initial rabbit rareness could have persuaded owners to adopt changes in habitat management that benefit big game species. The new ways of allocating investments (e.g. fences and water reservoirs instead of artificial warrens and smaller, more scattered water suppliers) probably helped rabbits to decline further.

Overhunting, which is common on small game estates, hampers recovery of rabbit populations that are already at low densities. As other game species, rabbits are hunted in autumn and winter. The late summer mortality peak due to myxomatosis, however, has prompted hunters to shoot rabbits just after the spring breeding period in order to compensate for expected bad bags in autumn. This special practice, though regularly authorized, is ill conceived because some rabbits that are able to transmit immunity to both myxomatosis and RHD are shot before they have had a chance to breed in autumn. In this way, the development of the population response against disease may be delayed.

Hunters, with good intent, sometimes try to reinforce wild rabbit populations by uncontrolled restocking that may introduce new problems. Procedures that expose wild rabbits to additional risks include: 1) inadvertent release of animals carrying new diseases, or new strains of diseases already present, 2) release during the inappropriate season, 3) deliverance of domestic-wild rabbit crosses, and 4) introduction of alien species (e.g. *Sylvilagus* spp.). Moreover, even when these potential problems have been anticipated and avoided, rabbit restocking is often inefficient because, for instance, artificial warrens are not always available or suitable, or released animals lack sufficient skills to avoid predation. The latter problems are common to every wildlife reintroduction or reinforcement, and have also affected better-planned releases for conservation purposes.

High levels of predation pose a problem for restocking, but also for the natural recovery of wild, low-density rabbit populations. Urbanization of wild areas, and leisure activities around them, are sources of increasing predation on rabbits in the form of feral pets or as a support to generalist predators like the red foxes, which are able to live at densities higher than the carrying capacity of the natural environment by feeding on dumps and scraps around houses.

2.6.1.4. Human-induced mortality

Available information indicates that a significant amount of lynx are killed directly by humans. Fully intentional illegal hunting still occurs, but its importance as a relative source of mortality is difficult to assess because these events are largely kept confidential. In Spain, the proportion of reports that involved illegal hunting during the 1980's was 26%. In Doñana, at least 5 lynx have been shot during the last 15 years. The annual mortality rate due to this cause has been estimated as 5% from the radio-tracked sample (n=63 lynx for >30,000 days). All the carcasses embodied gun pellets commonly used in small game hunting. Lynx are sometimes killed by hunters waiting in hides for red deer on the large hunting estates of the Iberian mountains. There are also reports of lynx caught by dogs during big game hunting, although this kind of death is rather uncommon. In Portugal, illegal shooting during legal game events or fox hunting, has been identified as the most important cause of mortality of lynx in recent time.

Traps have been, and still are, the main cause of direct human induced mortality in Spain, where trapping accounted for 44% of lynx deaths during the 1980's. In the past, when rabbits were abundant, hundreds of traps worked daily for several weeks in each hunting estate for rabbit harvest. Many furbearers, including lynx, died in those traps, as selling fur complemented the income of professional trappers. After the rabbit crash this occupation has almost disappeared, but as lynx survive in the best rabbit areas, where it is still worthwhile to set traps, some individuals are caught now and then. The impact of traps set for controlling predators as a mortality factor is much higher at present. In Sierra Morena Mountains the annual mortality rate due to this cause is at least 25% , according to radio-tracking of 12 lynx (>3,500 days). In Doñana, illegal trapping and hunting with dogs amount of an annual mortality rate of 6%. Fox control is allowed for short periods across the lynx range, but authorized methods, the duration of the trapping term, and the allowed number of traps are violated almost systematically. Non-selective methods are forbidden, but used everywhere. Selective methods (i.e. cages) are often used in non-selective ways (e.g. cages are seldom visited or predators, including protected species, are shot). Actual administrative control of these practices virtually does not exist, and established sanctions for confirmed violations are not efficient enough to prevent them. So far systematic trap inspection on hunting estates has rarely been done.

Traffic casualties caused 7% of lynx deaths during the 1980's, and it is believed that the impact of this cause of mortality is growing with traffic and road development. Road kills are impacting the Doñana population significantly (annual mortality rate of 4%). Given that lynx seldom feed on dead animals that have not been killed by themselves, poisoning is unusual, though the few reported cases might be related to predation of poisoned but still living animals. Among other uncommon causes of mortality, drowning in wells had local importance in the Doñana area in the 1980's. Some lynx have accidentally been kept confined within farm pens or enclosures.

2.6.2. Stochastic factors

2.6.2.1. Demographic viability

Some populations and many lynx subpopulations are comprised of less than 10 breeding females. This small size makes them extremely vulnerable to extinction just by random variation in individual birth and death frequencies. For instance, the probability that in a given year only half the adult females produce litters and that all juvenile that survive the first year are males, followed by high female mortality in the following year, is very low in a large population but has reasonable chances to happen in several Iberian lynx populations. Events of this kind strongly affect population structure and survival chances in the short term. In accordance with such possibilities, most small populations present in 1960 went extinct within 30 years.

2.6.2.2. Genetic viability

Theory states that genetic variability is lost quickly in small populations. Genetic studies have been attempted on the Iberian lynx only recently, and their results are still preliminary and inconclusive. There are, however, some signs of loss of genetic variability. For instance, in the small Doñana population, two pelt morphotypes have disappeared in the last 50 years. Some alleles that are still present in Sierra Morena populations have not been found in Doñana lynx. There is no clear evidence of inbreeding depression, but some data suggest low sperm quality in males living in the Doñana area.

2.6.2.3. Disease and catastrophes

The reduced genetic variability of small populations makes them more exposed to diseases. Disease has been identified as a relevant mortality factor in other wild populations of felidae, including the feral cat and the lion, and only occasionally in some species of *Lynx*, but not in the Iberian lynx. Diseases diagnosed in wild or captive specimens of other *Lynx* species are feline panleucopenia, distemper, feline leukemia, chlamydiosis, and toxoplasmosis, among others. Forest fires, flooding, extensive pollution, or new disease outbreaks in rabbits, may completely wipe out a small lynx population within a very short period of time.

2.6.3. Obstacles to conservation

Political, administrative, social, and economic reality imposes many obstacles to the implementation of efficient lynx conservation strategies. The following difficulties are most relevant.

2.6.3.1. Lack of coordination between administrations

As the Iberian mountains form natural boundaries between different regions, the conservation of most lynx populations is managed by at least two different regional administrations. Furthermore, some populations straddle the boundary between the two Iberian countries. Surprisingly, management programs of frontier lynx populations and habitats in different countries or regions have seldom been coordinated. In Spain, the Lynx Group of the Wild Fauna and Flora National Committee (Ministry of Environment) is a regular forum of information interchange on conservation measures undertaken by each regional Administration, but it is not aimed at transborder coordination.

Sometimes mechanisms of coordination are lacking even within the same administration, as different branches adopt contradictory decisions that influence lynx conservation. Important contradictions affecting lynx areas have also been detected in EU policies. Whereas some programs are aimed at implementing habitat improvement and other conservation measures, lynx habitat is simultaneously destroyed (usually at a higher rate) by developments that are financed by other European funds. Some examples include the already mentioned large infrastructures (road networks, dams, and irrigation projects) and afforestation programs.

Another shortcoming that hampers lynx conservation deals with the incorporation of newly acquired knowledge on lynx biology to conservation actions. Researchers (mostly public officials) publish their results in specialized journals that hardly reach the managers' desks. On the other hand, information is sometimes available but not taken into account by managers and planners. Reports by external consultants that appraise the effects of management or new developments on habitat and biodiversity, best illustrated by the Environmental Impact Assessment studies, regularly offer a poor ecological approach to the problems and, in particular, do not consider the existing knowledge on lynx biology.

2.6.3.2. Lack of incentives for the conservation of the lynx habitat

Several socioeconomic factors lead to the destruction of lynx habitat. Private agents seem to perceive higher profitability in the use of Mediterranean forest for recreation and big game hunting than in the traditional multiple land use linked to patchy optimal lynx habitats. Further elimination of lynx habitat is supported by public administrations through forestry programs and various forms of agricultural subsidies. On the other hand, economic or social incentives to preserve optimal habitats for rabbits and lynx do not exist.

2.6.3.3. Human attitudes toward small game predators and their control

Despite dominant trends leading to lynx habitat loss, large areas suitable for the species are still available in Spain. The major land use in these areas is red-legged partridge hunting, the management of which also favours rabbit populations. Lynx went extinct on most of these hunting estates a long time ago as a result of persistent, intensive predator control. Successful recolonization from existing lynx populations seems very unlikely because of several factors that often operate jointly. The distance between suitable areas without lynx and areas with lynx are sometimes beyond the species' dispersal ability. In other cases, shorter distances cannot be crossed because of unsuitable dispersal habitat. Source populations may be so weakened that dispersal rates are very low. Finally, a critical reason is that predator control goes on in most small game hunting estates.

Hunters and gamekeepers concerned with small game consider red fox and other generalistic predators to be extremely harmful to their business, and predator control suppression is out of the question. Efficient methods for predator control are non-selective and, regrettably, alternative selective methods that are able to compete in efficiency have not been developed yet. Taking into account the general trends in land use, this particular methodological problem has crucial implications for lynx conservation.

2.6.3.4. Limited knowledge

Important decisions relevant to conservation necessarily rely on limited information about lynx biology, ecology, and behaviour. These aspects are barely known outside the Doñana area. Studies of other lynx populations have dealt with diet, distribution, and causes of mortality. A short (three years) research project has been conducted in a locality of Sierra Morena, but only

a few lynx, mostly juveniles, were studied there. Another radio-tracking project is being attempted at the eastern end of Sierra Morena at present. Finally, a genetic study, still in progress, involves collection of samples in lynx populations outside Doñana. In summary, scant information about many aspects of lynx biology is clearly a great limitation for the development and implementation of a conservation plan.

2.7. Conservation status and recent conservation measures

The Iberian lynx is legally protected by the following laws and conventions:

1. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES; Washington 1973). Listed in Appendix I: species threatened with extinction which are or may be affected by trade. Trade in specimens of these species must be subject to particularly strict regulation in order not to endanger further their survival and must only be authorized in exceptional circumstances.
2. Convention on the Conservation of European Wildlife and Natural Habitats (Bern 1979). Listed in Appendix II: strictly protected fauna species.
3. Spanish law 439/1990 concerning the National Catalogue of Endangered Species. Listed in Appendix I: endangered.
4. Portuguese game law (1974) excludes the Iberian lynx from the game species list, and therefore its capture is forbidden.
5. Council Directive 92/43/EEC (European Commission), Conservation of Natural and Wild Fauna and Flora. Listed in Appendix II*: priority species among those requiring special measures of habitat protection. Also listed in Appendix IV: strictly protected.
6. Portuguese Ministers Council Resolution n^o 142/97 (28 August) concerning the National List (First phase to submit to EU) that includes some Lynx areas.

In addition, in 1996 the Iberian lynx was ranked by the IUCN Cat Specialist Group as the most vulnerable felid species in the world (Category 1), according to factors which influence population size and extinction risk.

Several specific initiatives concerning lynx conservation have been undertaken in the last ten years. The former Spanish Institute for Nature Conservation (ICONA, nowadays a branch of the Ministry of Environment) funded the 1988 survey which revealed the strong range contraction and recent population decline of the Iberian lynx. Since then, both ICONA and the Spanish regional administrations have performed a number of conservation efforts, most of them within the framework of a LIFE project, co-funded jointly with the European Commission (DG XI). Similarly, the Portuguese Institute for Nature Conservation has been involved in a LIFE project, and is preparing a national conservation plan. These efforts, however, often clash with other, more powerful, sectorial policies (agriculture, forestry, transportation, water management and so on). In February 1998, a workshop on Iberian lynx conservation was organized by the Spanish Ministry of Environment and the IUCN Conservation Breeding Specialist Group, attended by representatives of the Spanish regional administrations, central administrations of the two Iberian countries, researchers, conservationist NGOs, and other concerned social groups. Most issues treated in the present Action Plan were widely discussed in that meeting, whose resulting recommendations were compiled in a document (still unpublished) which will be used by the Spanish authorities as guidelines for an Iberian Lynx Recovery Strategy.

3. Goals and objectives

The goal of this plan is “to conserve and recover populations in order to ensure their viability in long term of the Iberian lynx, an European endemic, as an essential element of the Mediterranean forest ecosystem in the Iberian Peninsula”. This goes through stopping the present decreasing trend of Iberian lynx populations and turning them into viable populations. The lynx ecosystem depends on a specific kind of traditional management that has operated for millennia. To attain this goal it is indispensable to retain every functional element of this man-shaped ecosystem. Only saving the Iberian lynx from extinction will grant Europe the moral authority to call for the conservation of biodiversity in other parts of the world.

3.1. Objective 1

Increase the size of the extant Iberian lynx populations up to levels that guarantee long-term viability, and maximise connection between isolated populations, especially small ones, in order to reduce their risk of extinction.

3.2. Objective 2

Favour natural or, where required, assisted recolonization primarily in areas where lynx have disappeared in the last decades, in potential lynx areas for recuperation, or in other areas where a successful reintroduction would be feasible.

3.3. Objective 3

Develop new and alternative ways to make profitable the preservation of every functional element in the Mediterranean forest, as the only sustainable way to achieve objectives 1 and 2.

4. Actions required to meet goals and objectives at the European level

4.1. Lynx conservation: co-ordination and planning

Compared with large carnivore standards, the Iberian lynx has a reduced range, limited to two European countries. Hence, the implementation of an international co-ordinated strategy for its conservation will not be really complex. Once the present Action Plan will be adopted by the Bern Convention, its main features could be incorporated into: a) the European Union biodiversity conservation policy; b) a national plan for the conservation of the Iberian lynx in Portugal; and c) a global strategy for the conservation of lynx in Spain that provides the basic settings for regional recovery plans. In Spain the CA Administrations could endeavour to institute a co-ordinated conservation policy in order to optimise their efficiency in the management of shared lynx populations.

One of the primary tasks of the Portuguese National Plan and the Spanish National Strategy is to define a ‘lynx area’, i.e. the area where long-term conservation plans should be applied. Obviously, the limits of this area have to exceed not only the current distribution of the species, but also the known limits of the lynx range during the late 1980’s, as by then range fragmentation was strong enough to preclude the persistence of many populations in the long-term. The lynx area must also include places where corridors or other habitat links will be placed in order to connect isolated populations, as well as other areas having the potential for lynx natural recolonisation or assisted reintroduction. Besides, the Spanish Strategy and the Portuguese Plan need to clearly state priorities, time schedules, financial sources, and monitoring programs in order to accomplish all the actions proposed in the present Plan.

To collaborate with Portuguese and Spanish Administrations, and promote joint work between them, it is strongly recommended to establish specific working teams in each country. A full-time supervisor with co-ordination and monitoring functions should be at the head of each group. From the beginning, each team should include representatives of every involved sector: the appropriate administrative branches, researchers, NGOs, landowners, hunters, and so on. Specifically, the Spanish team should incorporate representatives of the CA that harbour lynx within their boundaries. It would be convenient that this group be inserted within the already established Lynx Group of the Wild Fauna and Flora National Committee. Some members of both Spanish and Portuguese teams are expected to set up a Mixed Committee facilitating co-ordination between policies at the country level. Where required, the declaration of areas harbouring transborder lynx populations as international reserves with co-ordinated management could be considered.

To confer legal meaning to these conservation efforts, it would be convenient that the Portuguese National Plan and the Spanish National Strategy were published in the respective national official gazettes, and that plan guidelines were formally stated in an Iberian international agreement. It is recommended that lynx conservation plans will be officially published as soon as possible; given the current status of the Iberian lynx, the approval and publication of the plans should be ready before the end of 1999.

Comprehensive information about the problems of lynx, as well as conservation plans and strategies, should be diffused widely, with special emphasis on administrative sectors involved in habitat management and rural economy. In case of conflictive initiatives between different administrative branches, the critical situation of the Iberian lynx compels giving priority to the conservation of this species and its habitat. Arbitration mechanisms to establish this priority could be developed.

Actions:

- 1.1. The Bern Convention adopts this Action Plan and proposes it to the Portuguese and Spanish authorities.
- 1.2. The governments of Portugal and Spain set up an interdisciplinary team to draw up, co-ordinate, implement, and supervise the Portuguese Plan and the Spanish Strategy for the Iberian lynx conservation, respectively. With regard to the Spanish part, this strategy has to fit into the recovery plans of every involved CA. Each team is co-ordinated by a full-time supervisor.
- 1.3. Develop specific formulas of trans-regional and trans-national co-ordination in lynx management (e.g. international reserves).
- 1.4. Integrate specific conservation measures for the Iberian lynx into existing laws and regulations and, if necessary, provide new legal coverage to such measures.
- 1.5. Publish the Iberian lynx conservation plans and strategies in the official gazettes.

4.2. Habitat protection and restoration

The Mediterranean scrubland has been traditionally exploited for a number of practices that have almost disappeared. Some of them do not make sense any longer (e.g. charcoal production for fuel), have a marginal social implantation (e.g. subsistence agriculture), can be performed in alternative ways (e.g. apiculture), have been replaced by other uses (e.g. small game hunting has been replaced by big game hunting or forestry), or are now carried out in an intensive way (e.g. livestocking). Furthermore, whereas the massive abandonment of rural areas 40 years ago caused the disappearance of traditional agriculture, the current trend of people coming back to natural areas, carrying different, more impacting activities than formerly, involves even more detrimental consequences for lynx habitat. As a result, what can be called the 'rabbit ecosystem' (following the black-footed ferret, *Mustela nigripes*, conservation plan, in which the term 'prairie dog ecosystem' was coined), is bound to be lost.

New and attractive formulas to conserve the Mediterranean forest, and in particular the rabbit ecosystem, are needed. The European Administration is, therefore, strongly recommended to undertake a specific plan that addresses this task. Afforestation policies are certainly imperative in most European countries, but in the Mediterranean habitats of the Iberian Peninsula it is much more useful, from a conservation point of view, to promote land uses that make scrubland preservation possible. Moreover, due to the relatively slow response of Mediterranean ecosystems to perturbation, allowing or enhancing natural forest dynamics may be generally preferred to more aggressive techniques, such as scrubland removal followed by planting.

Spanish and Portuguese administrations should find new ways to encourage private landowners to protect and restore lynx habitat, so that the presence of lynx represents a regulatory asset rather than an economic liability. Possible incentives include subsidies to manage scrubland in proper ways, tax exemption for small game estates, rewards, public acknowledgement, and so on. Advances in the conservation of the rabbit habitat will also help other threatened species, in particular the Spanish Imperial Eagle (*Aquila adalberti*).

The quality of the lynx habitat has to be preserved by minimizing human disturbance. Hard land uses (e.g. transport facilities, dams, power plants and other industrial facilities, urban areas) must be avoided within the defined area where actual and potential actions will be undertaken. Every activity entailing habitat alterations has to be regulated and submitted to Environmental Impact Assessment. The body of laws and norms concerning the use of Environmental Impact Assessment should explicitly consider more strict control of activities affecting areas inhabited by lynx populations. The opinion of environmental technicians should have binding value.

Increasingly popular activities, such as rural tourism and some outdoor sports, fit in the frame of a well-conserved lynx habitat. If those and other activities, including hunting, are carried out properly, they may be compatible with long-term lynx survival and should be encouraged.

Although the philosophy of this plan recognises the importance of consensus between different social groups and interests as the best way to make lynx populations to last, it is also true that, in specific situations, the intervention of the administration might be necessary to ensure the persistence of critical lynx populations. In these cases, special restrictions in land uses such as large developments, urbanisation, hunting, forestry or recreation may be needed, sometimes during extended periods.

Actions:

2.1. Define a so-called “Iberian lynx potential area”, whose limits coincides with the Mediterranean scrubland in the Iberian peninsula plus some Atlantic areas in Portugal. This is the region where the following measures are going to be applied, giving priority to the lynx range identified in 1988 for Spain, and to the actual areas of regular presence in Portugal.

2.2. Revise the interpretation of the European policy of subsidies to afforestation in abandoned agricultural lands, so that the old fields already colonized by natural shrub species are not replaced by new plantations. Develop technical criteria to convert abandoned agricultural lands, and to improve forestry lands, into habitats suitable for the Iberian lynx.

2.3. Establish economic incentives, tax exemption, and other facilities aimed at the conservation of Mediterranean scrubland and its proper management towards the optimal requirements of the Iberian lynx.

2.4. Stop the physical removal of scrubland vegetation.

2.5. Prevent the degradation of the Mediterranean forest through requirement of a special EIA bond whenever a new activity is projected in the potential lynx area. The opinion of environmental technicians will be of binding value.

2.6. Identify areas for the establishment of ecological corridors to restore lynx dispersal between populations currently isolated. Pay special attention to the potential role of riparian habitats as corridors. Manage habitat and reduce mortality risks within these linear elements to guarantee an

efficient connection.

2.7. Promote products with “lynx” label, made of raw matters produced in “lynx areas” through processes involving activities compatible with preservation of Mediterranean scrubland (e.g. cheese from extensive sheep-raising, honey, pollen).

2.8. Define the conditions in which special strict intervention of the administrations on land uses can be applied to protect critical lynx populations, and adopt the pertinent legal amendments. Specify the time framework (temporal or permanent) for these special actions.

2.9. Provide information about sensitive areas for the conservation of Iberian lynx to public agencies dealing with large development projects (road and railway networks, reservoirs, channels, new residential areas, mines and other industry) in order to minimise the impact of such developments already at an early stage.

2.10. Give the status of untouched area to breeding zones, clearly identified, where activities such as afforestation, hunting and building of infrastructures must be forbidden. Tranquillity must be ensured in breeding areas.

4.3. Rabbit population recovery

Lynx conservation cannot be separated from rabbit recovery. Like habitat degradation, the rabbit decline is a generalised phenomenon that needs global solutions. The almost complete extinction of rabbits in many places has been a gradual process, whose roots lie beyond the proximal cause of myxomatosis and RHD. The above-mentioned changes in habitat helped rabbit populations to decline. Therefore, measures endeavouring at lynx habitat improvement have to include specific actions that help rabbits build up their numbers (e.g. small-scale land-clearing and cereal growing, artificial warrens, drinking troughs).

Diseases need special attention. Although the proportion of immune individuals within rabbit populations seems to have increased, both myxomatosis and RHD still have a great influence on rabbit population dynamics. Studies on the use of potential vaccines and antiparasitic treatments are required. At the same time, any treatment has to be chosen and supervised carefully, keeping in mind that no short-term magic solution is to be expected.

The way small game estates are managed is another key point for rabbit recovery. The already disease-decimated rabbit populations will probably not bear further hunting pressure before a substantial recovery. Rotative close seasons on a local scale should be flexibly established, moulding their length and features to the specific characteristics of rabbit populations in each place. Rabbit hunting should stop during summer, when the virulence of myxomatosis reaches its annual peak and some rabbits get the chance to survive this critical period, become immune and breed later on. The administrations, specially in Spain, have to encourage private initiatives to strengthen small game hunting where appropriate, as an alternative to the overdominating big game hunting.

In most cases it is hard to know in detail the relative importance of predation on rabbit population dynamics, as the impact of predation depends on many factors varying from place to place. In addition, the effects of predator control on rabbit recovery are often unsatisfactory beyond the very short-term and, above all, many predator species are strictly protected, and the most common methods of predator control are non-selective and forbidden. Thus, predator control cannot be recommended as a general practice favouring rabbit abundance. However, detailed studies may reveal that predation critically depresses rabbit density in some situations. In these particular instances, it may be desirable to reduce predation levels. Predator control programs should start reducing the abundance of feral species (dogs and cats) and non-protected generalist species (red fox and wild boar) by depleting artificial food sources. In some extreme cases, capture, followed by translocation, sterilisation or death, may be considered as well. For these exceptions, only selective methods of predator control should be used. Predator management has to be monitored by skilled technicians.

Actions:

- 3.1. Restore land use practices that facilitate the presence of rabbits, based on scientific grounds. Introduce modifications in agricultural, forestal, and hunting practices that favour an increase of rabbit density.
- 3.2. Promote small game hunting and, in particular, sustainable rabbit hunting through incentives to hunting societies and game managers.
- 3.3. Establish guidelines for rabbit restocking, translocations and monitoring of rabbit populations through references in the current laws.
- 3.4. Couple the rabbit hunting seasons with annual variations in local population sizes in such a way that maximises breeding and the spread of resistance against viral diseases. Hunting during summer must be avoided.
- 3.5. Limit the availability of artificial resources to generalist rabbit predators.
- 3.6. Promote control programs for feral dogs and cats, involving the authorities with legal obligations on this matter.

4.4. Reduction of mortality causes

Although lynx deaths by illegal shooting occur, the real impact of this cause of mortality on lynx populations is unknown. In Portugal gunshots seem to be the major cause of mortality, according to recorded deaths. The reduction or, preferably, the elimination of this cause of mortality goes through

- a.* Improving the attitude of the society, in general, and of hunters, in particular, towards the Iberian lynx. Any person who shoots a lynx should be reported and evicted by his own social group, and legal mechanisms, which already exist, against poachers should act with their whole strength. For these purposes, specific awareness campaigns are needed (see below).
- b.* Increasing the vigilance and, where appropriate, punishment of lynx shooters; and investigating the possibility of making the managers of hunting areas, or the organizers of hunting events, to bear the civil liability of illegal deaths, at least when they do not collaborate in finding the poacher.

The use of leg-hold traps and snares as methods for controlling game predators is forbidden by national and European laws since 1991. In Spain, since then, such non-selective methods have been allowed for that purpose by some regional Administrations every year, making use of an exceptionality clause in the Spanish legislation. Permits usually stated a short period and/or a small number of traps, in order to limit game predation by red fox (non-protected in Spain). A violation of the permit conditions (extended duration, and much larger number of traps than allowed) has been common in many hunting estates. As a result, leg-hold traps and snares have worked regularly, and still are one of the main mortality causes in the Iberian lynx. The use, regardless of the aim, of these or any other non-selective methods (as poison) in lynx areas must be enforced vigorously. Alternative selective techniques for controlling populations of some predator species should be developed, in case this tool will be needed in the future to solve wildlife management problems that cannot be addressed by other methods. Furthermore, establishing procedures aimed to guarantee that these selective methods are used in a selective fashion is needed. One possible solution to the potential need of controlling predators in special situations would be establishing a controlled system of 'professional trappers', properly educated who should demonstrate their skills through tests. This is, however, a delicate point to be widely discussed between the Administrations and all the social groups involved before a decision is taken in this direction. As in the case of shooting, the convenience of giving the liability of illegal trapping to the owners of the hunting rights has to be considered. Discussion on the legal framework, as well as on the procedures for the control of these activities, should also be taken into account.

Many of the illegal captures of lynx in leg-hold traps and snares happen in 'passageways' or holes in fences enclosing large game reserves. In all actual or potential lynx areas, those fences must be open enough at the bottom allowing free movements of lynx and other mammals.

Road kills have become one important mortality cause for lynx. New roads crossing stable lynx populations must not be constructed, and those built or modified in areas potentially used by lynx must have wildlife passages in favourable points, accompanied by deterrent measures along particularly dangerous stretches. It is important to document the effectiveness of wildlife passages across roads and other linear developments.

In the Doñana area the frequency with which lynx died drowned in water wells was surprisingly high. Just covering those wells was enough to avoid this cause of mortality. Wells in lynx areas should be covered and alternative water places provided. In any case, there is always the possibility that, in areas other than Doñana, unexpected, but locally important causes of mortality could exist, that can only be detected through research.

There are no records of deaths caused by health problems or diseases, but they can not be discarded because not all necropsies have been always done as accurately as desired. As a preventive measure it would be useful to monitor the health of domestic animals and other wild carnivores living in lynx areas, as well as to collect samples from all lynx individuals found dead or captured alive for other reasons.

Actions:

- 4.1. Enforce the legal banning of leg-hold traps, snares and any other non-selective predator control methods in all the potential and actual distribution areas of the Iberian lynx.
- 4.2. Strengthen the vigilance and reinforce the punishment mechanisms in order to avoid killing lynx by shooting.
- 4.3. Develop alternative selective techniques and procedures of predator control that could be used as a management tool by the Administrations, if needed in exceptional circumstances.
- 4.4. Promote the open discussion of the professionalism of predator controllers in forums where all the groups of interest (administrations, hunters, game producers, conservationists, technicians, researchers) will be represented.
- 4.5. Co-ordinate the process of decision for construction of new roads in areas where stable lynx populations are present, taking lynx areas in consideration at the conception/ planning level. When unavoidable and in potential distribution zones, new roads must have efficient wildlife passages, especially in identified high-risk crossing sites.
- 4.6. Cover wells and evaluate any other possible, locally relevant mortality factors.
- 4.7. Evaluate sanitary risks, with a monitoring of the lynx populations and other sympatric populations of both domestic and wild species.
- 4.8. Submit predator control actions in lynx areas to technical analysis and authorisation from environmental authorities.

4.5. Public education and information.

The dramatic situation of the Iberian lynx is often divulged by the media in Spain and Portugal, and to a lesser extent, in other European countries. However, they usually contain only generic messages, which are not oriented to any specific social collective and, hence, they are probably not very effective in practice. Studies on the attitudes of different collectives (managers, land owners, hunters, cattle raisers, etc.) to the issues related to the conservation of the Iberian lynx, and the Mediterranean scrubland ecosystems in general, should be done. According to the results of these studies, campaigns specifically oriented to inform and make people aware about particular problems and their possible solutions should be designed. Some of these campaigns should be extended to the rest of Europe, as the conservation of the Iberian lynx and Mediterranean scrubland ecosystem is a problem and a responsibility of all the Europeans.

Specific public informative and awareness campaigns should be aimed at least at land managers (both public and private), conservation technicians, land owners, game producers, hunters, promoters of rural tourism, local and regional politicians and mass media. They should be informed not only about the species situation and the restrictions imposed to their activities as a consequence of this situation, but also (and mainly) the advantages derived from the presence of the lynx, and the incentives to be provided for facilitating its conservation.

The incentives and advantages derived from the conservation of the lynx clearly are not only economic ones. It is important to generate at all levels (general public opinion, regional governments, land owners) feelings of pride and self-satisfaction because of having lynx and being able to conserve it. A public recognition, at the highest level, of the estates (both private and public) where lynx survive would be useful. This recognition status could be renewed annually.

Education and awareness campaigns should be implemented using professional criteria, designs and techniques. Moreover, their success on the target social groups should be evaluated objectively. Continued education of people working at conservation agencies will undoubtedly help them to enforce laws and regulations in a more efficient way.

Actions:

- 5.1 Identify the different social groups which need different messages in relation with the conservation of the Iberian lynx and, in general, of the Mediterranean scrubland ecosystems .
- 5.2. Design, with professional schemes, informative, formative, and awareness campaigns directed towards different collectives, evaluating objectively their efficacy.
- 5.3. Promote in all the European countries (not only the Iberian ones), the pride of having lynx and the responsibility of preserving them.
- 5.4. Divulge as much as possible the incentives and advantages, both direct and indirect, derived from the conservation of the lynx and its environment.
- 5.5. Improve the education of the staff at public agencies in order to make a clear understanding of the aims and rules concerning lynx conservation that affect land uses, human activities and wildlife management.

4.6. Protection of the areas of actual presence of the species and promotion of their connections

All the conservation proposals presented above are aimed at reversing the tendency towards extinction of the Iberian lynx, and finding effective measures in the stabilization of the populations at levels which ensure their long term viability. However, we can not forget that current tendencies are very regressive and, therefore, protective measures in areas where presence is currently presumed should be implemented in the short term. For this purpose most, if not all, areas where lynx presence was detected in the Spanish 1988 survey and the Portuguese 1994-96 survey should be subjected to special protection and, whenever possible, integrated in the Natura 2000 Network as “Sites of Community Importance” (SCIs). The declaration of SCIs should be extended to new presence areas that could be discovered in the future, or to those affected by natural or assisted colonizations.

Given that the isolation of the Iberian lynx populations, as a result of fragmentation, is itself a serious threat, areas which could act as corridors between isolated populations should be subjected to special protection. Research is needed to identify these corridors. In the mid- and long-term, the possibility of promoting restoration of habitat corridors between lynx areas separated by unsuitable habitat for dispersal should be studied.

The declaration of SCIs within the Natura 2000 Network will hopefully entail incentives as those reported in previous paragraphs and improve public awareness. Those areas could act as 'pilot areas' for the implementation of national and regional plans for the conservation of lynx.

Actions:

- 6.1. Propose the declaration as SCIs (Natura 2000 Network) of enough areas to guarantee the long-term viability of lynx populations.
- 6.2. Provide especial protection to all the areas that are suitable as corridors between isolated populations.
- 6.3. Promote incentives and public awareness in SCIs, in relation to previous recommended actions.
- 6.4. Study, in the mid- and long-term, the possibility of constructing or recovering corridors across areas isolated by impermeable barriers.

4.7. Reduction of the risks of inbreeding.

Together with mid- and long-term actions to connect isolated populations through corridors, the best way to reduce the risk of inbreeding in the short-term could be the translocation of individuals. However, the lack of information about composition and structure of populations and about their genetic characteristics makes detailed action proposals very difficult before carrying out new research. The analysis of potential risks due to outbreeding depression should not be disregarded.

Actions:

- 7.1. Promote research on the composition and structure of the different lynx populations and of their genetic characteristics.
- 7.2. Promote the natural communication among population through the dispersal by preserving and restoring, where necessary, the natural corridors connecting populations.
- 7.3. Design translocation projects, based on the results of that research, in order to minimize the loss of genetic variability in the short-term, when natural connection via corridors was not viable. The management of the Iberian lynx population has to prevail over other land uses in potential areas chosen for restocking or reintroduction, at least until the population stabilizes.

4.8. Captive and 'semi-captive' breeding.

Captive breeding has been proposed as a recommendable method for the conservation of species under imminent risk of extinction. In fact, in 1987 the IUCN suggested the beginning of captive breeding programs as soon as global population sizes of a species become reduced to a few thousand individuals. Using this simple rule, the Iberian lynx is a clear candidate for captive breeding. However, during the last decade the usefulness previously attributed to captive breeding as a conservation tool has been seriously questioned. There is evidence that animals kept in captivity lose adaptability to life in the wild, through genetic, physiological and behavioural changes. On the other hand, betting strongly for captive breeding (which is a very expensive method) can take crucial resources away from *in situ* conservation actions. Captive breeding projects can only be considered as strictly short-term conservation tools, and must never be implemented before they are absolutely necessary.

Due to the precarious situation of the Iberian lynx, it is not unlikely that individuals coming from a captive stock might be required in a crisis situation. There is no experience about breeding this species in captivity, so that an experimental program for developing breeding techniques and managing lynx in captivity should be urgently performed. For this purpose, already captive individuals and a limited number of animals captured in the wild (from different populations) should be used. The Experimental Program must be a part of the Lynx Recovery Plans, have a sound scientific base, and have enough social and governmental support. It is recommended that the efforts be divided between at least two geographically separated centres. The already existing "Iberian lynx experimental breeding center" in the surroundings of the Doñana National Park can be a useful starting point for this purpose. The objectives of the captive breeding project and the final destination of animals born as a result of the project must be clearly defined from the beginning.

If the objective is to produce lynx for restocking, it could be interesting to try a soft-breeding method, so called semi-captivity, i.e. inside enclosures large enough (several hectares), with free living preys (rabbits) and where lynx could be kept away from human contact.

Actions:

8.1. Design and develop as soon as possible a scientifically sound program of experimental captive breeding for the Iberian lynx, within the framework of national plans for the recovery of the species.

8.2. Study the viability of breeding Iberian lynx under semi-natural conditions, in large enclosures (several hectares) free from direct human influence, where animals could use natural prey and shelter.

8.3. Create a bank of lynx genetic material to be used, if necessary, in the experimental captive breeding program, and as a preventive measure to cope with a potential further genetic impoverishment of wild lynx populations.

8.4. Identify the areas where restocking and/or reintroduction would be a) optimal in terms of the global persistence of the species, according to the spatial configuration of populations, and b) feasible, in terms of suitability of habitat, land ownership and uses, human activities and attitudes, and stability of prey populations.

8.5. Develop technical criteria of management of injured lynx, and its potential fate, after recovering, as animals released back in the wild or, alternatively, as captive breeders.

8.6. Promote co-operation between the two Iberian countries in planning and undertaking measures concerning genetic banks, injured animals, and experimental captive breeding.

4.9. Monitoring and research

A deeper knowledge of lynx distribution, abundance, population dynamics, and other aspects of its ecology, especially outside the Doñana area, is an essential element for the implementation of an effective conservation plan.

4.9.1. Estimation of presence and abundance

An updated information on lynx range limits and density distribution is the basis of any recovery plan. Due to its shyness and elusive behaviour, commonly used census techniques are almost useless. Track searching is of a very limited application due to the general lack of snow and the common ground hardness that characterises lynx areas. So, finding an objective method to check the presence and estimate the abundance of lynx is crucial for both monitoring and assessment of the conservation measures undertaken. Such a method must be developed, and research on this subject is urgently needed. A proper methodology could include the use of photographic devices, track- and hair-traps in association, or not, with the use of different kinds

of lures, i.e. olfactory, visual, and auditory. Alternative, more expensive methods, that reliably relate the species identity to chemical or genetic markers present in lynx hair or faeces should be explored.

4.9.2. Population dynamics: population structure, reproduction, dispersal, rates and causes of mortality, models of population viability

Recruitment, mortality rates and causes, as well as the spatial structure of lynx populations have to be known to plan a conservation strategy. Most lynx are likely to live in metapopulations with source-sink dynamics, i.e. juveniles coming from source areas suffer mortality in larger sink areas. The conservation of the habitat only in the sinks and not in the sources, without a decrease of mortality in the former, may have a long-term negative effect on overall chances of survival. Therefore, priority has to be given to preservation of habitat and enlargement of the area occupied by the sources and to reduction of mortality factors in the sinks.

The limited knowledge about population characteristics of the Iberian lynx is restricted to the Doñana area. Even there the factors influencing breeding (productivity, cub survival, age of first reproduction, lifetime reproductive success, etc.) are unknown. Research is needed in order to identify lynx population structure, in particular its spatial structure (sources and sinks), in mountainous areas. It is also necessary to estimate mortality rates and to identify direct mortality causes, but also factors that may influence individual fitness, such as diseases.

4.9.3. Habitat requirements

Current knowledge on lynx habitat has been described broadly in this document. Some progress has been made in the characterization of the lynx habitat, especially at a large landscape scale. Favourable and unsuitable habitat elements have been identified in this way. Nevertheless, although some thresholds in the proportion of suitable elements required for the lynx to be present have also been identified, much more effort is needed in order to model the relationship between habitat quality and lynx density. A further step would be quantifying relevant resources within a particular habitat and determine the functional dependence of lynx density on them, and the mechanisms influencing density. Research should address this questions not only at the landscape scale, but also at lower spatial scales. Results will hopefully provide a rationale for habitat evaluation and will help decision making in lynx conservation.

4.9.4. Inter and intra-population genetic variation

Information about genetic variation within and between different isolated demes is needed for two different purposes. First, to document the existence of genetically differentiated groups which should be managed as different populations. This information must precede any translocations or reintroduction efforts, as outbreeding depression must be avoided. On the other hand, the degree of expected loss of genetic variation because of inbreeding inside populations with low effective population must be determined. The information about the degree of inbreeding is necessary for giving an order of preference for the populations that would need translocation, restocking or reintroduction.

4.9.5. Landscape ecology and lynx conservation: design of corridors

Because of the extremely fragmented distribution of the Iberian lynx, some small isolated populations only persist thanks to immigration from neighbour populations. When immigration stops, these small populations rapidly go extinct. Immigrants are actually dispersing individuals and, as the dispersal frequency of arrival decreases with distance to the source population, the spatial configuration of populations is an important feature for overall survival. It is likely that the patchy distribution of lynx reflects the distribution of suitable habitats. Dispersal should be facilitated between patches of breeding habitat by maintaining links or corridors. More research is needed to determine which types of corridors best favour direct and rapid lynx movements across unsuitable, and sometimes dangerous, matrix habitats. Models of dispersal habitat should look at the relationships between matrix width, matrix quality, the probability of lynx to enter the matrix, and the probability of dispersing lynx to reach another population. Different corridor designs can be incorporated to these models.

4.9.6. Population ecology of rabbits

Provided that high level of rabbit abundance is essential for the lynx persistence, more must be known about rabbit population dynamics. Factors determining the abundance and distribution of rabbits, including diseases, habitat characteristics, game management, and predation, should be investigated.

4.9.7. Parasites and diseases

The effect of parasites and diseases on the population dynamics of the Iberian lynx are completely unknown, and little is known on diseases circulating in Spanish populations of wildcat and feral domestic cats. Small localized metapopulations, suffering a loss of genetic variability and sharing their habitats with bigger populations of related wild and domestic carnivores, are strongly vulnerable to stochastic events such as diseases.

4.9.8. Identification of public values and attitudes towards the conservation of the Iberian lynx and the Mediterranean scrubland ecosystem

The effectivity of the conservationist messages sent to different collectives is severely influenced by the values and attitudes of each social group, i.e. the messages for land owners and for childrens at the school must be definitely different. Research to identify target collectives and their main points of interest, in order to design effective educative campaigns should be done.

Actions:

9.1. Promote research programs covering the objectives stated above.

5. Required actions by country

Provided the small distribution area of the Iberian lynx and the high habitat specificity, the actions recommended in section 4 are common both to Portugal and Spain, as it has been reflected in the text and in Table 4.

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8. Tables

Table 1: Status of *Lynx pardinus* populations in Europe by countries. Numbers identifying populations correspond to those in Figure 1. Populations shown in the table are really metapopulations or groups of populations connected through a variable flux of dispersing individuals. In third column, "Country" refers to Portugal (P) and "Regions" to Spanish autonomous regions (AND = Andalucía, CLE = Castilla-León, CLA = Castilla-la-Mancha, EXT = Extremadura, MAD = Madrid). Number of lynx, areas and densities are approximated figures. Estimation methods: fi = field inquiries by means of interviews or questionnaires, fs = occasional search of field signs, rt = radio-tracking. Trend: → = stable. ↘ = decreasing, ? = unknown.

Country	Population	Country or Region(s)	# of lynx	Total Area (km ²)	Mean Density (ind/100km ²)	Estimation Method	Population trend
PORTUGAL	1 Algarve-Odemira-Sado Valley	P	25-30	1300	1.6-2.2	fi, fs	↘
PORTUGAL-SPAIN	2 Gata-Malcata-San Pedro-S.Mamede	P-EXT-CLE	75-95	2050	1.7-4.6	fi, fs	↘
	3 W.Sierra Morena-Guadiana	P-AND-EXT	40-45	1300	1.9-3.5	fi, fs	↘
SPAIN	4 Alberche	MAD	5-10	270	1.9-3.7	fi, fs	↘
	5 Gredos	CLE	8-12	370	2.2-3.2	fi, fs	↘
	6 Subbéticas	AND	25-30	540	4.6-5.6	fi, fs	?
	7 Doñana	AND	40-50	540	7.4-9.3	fs, rt	→
	8 Central Sierra Morena	AND	60-65	760	7.9-8.6	fi, fs	?
	9 Central Population (E.S.Morena-Montes de Toledo-Villuercas)	AND-CMA-EXT	350-450	9100	3.8-4.9	fi, fs	↘

Table 2: Legal status, management, and conservation actions of *Lynx pardinus* in progress in European countries. Institutions in charge and Management levels: Nat. = National Institutions (Nature Conservation Institute in Portugal and Ministry of Environment in Spain), Reg. = Regional Environmental Agencies, only in Spain. * Monitoring: a systematic system of monitoring of lynx populations is not currently being applied, due to a lack of an objective and easily repeatable methodology of censusing lynx.

Country	Legal status	Enforcement	Institution in charge	Management level	Management Plans	Monitoring	Information	Research
Portugal	Fully protected	Total	Nat.	Nat.	In preparation	No*	Yes	Yes
Spain	Fully protected	Total	Nat., Reg.	Reg.	In preparation	No*	Yes	Yes

Table 3: Identified threats to the Iberian lynx (*Lynx pardinus*) in the European countries. XX = serious threat, X = minor threat, (X) = suspected threat in the future, L = local threat.

Country	Habitat loss	Habitat fragmentation	Prey scarcity	Ilegal hunting	Traffic kills	Small pop. size	Diseases	Lack of coordination	Lack of incentives	Public attitude
Portugal	XX	XX	XX	X	X	XX	(X)		XX	L
Spain	XX	XX	XX	X	X	XX	(X)	X	XX	L

Table 4: Actions required for preserving *Lynx pardinus* populations by country. Given the similarity of the threats for Iberian lynx populations in the countries containing them, actions proposed are also similar for both countries. SCIs = Sites of Community Importance in Europe of the Nature 2000 Network.

Actions required	Portugal	Spain
International co-ordination	+	+
Inter-regional co-ordination		+
To design conservation plans	+	+
Research and monitoring	+	+
To define potential lynx region	+	+
To restore Mediterranean scrubland	+	+
Economic incentives in Med. Scrubland estates	+	+
To stop Mediterranean scrubland removal	+	+
To prevent Mediterranean scrubland degradation	+	+
To recover land use practice favouring rabbits	+	+
To promote game practices increasing rabbits	+	+
To design guidelines for rabbit restocking	+	+
To define rabbit hunting seasons	+	+
Banning of non-selective traps	+	+
To promote professional predator controllers		+
To increase surveillance on lynx killing	+	+
To avoid new roads in lynx areas	+	+
To cover wells in lynx areas	+	+
Evaluation of sanitary risks	+	+
Identification of social groups for public campaigns	+	+
Design of public awareness campaigns	+	+
To promote “pride” of having lynx	+	+
To make public the advantages of having lynx	+	+
To designate areas of lynx presence as SCI's	+	+
Incentives and awareness in SCI's	+	+
Restoration of corridors	+	+
Research on genetics	+	+
Lynx translocations to avoid risks of inbreeding	+	+
To design an experimental captive breeding program	+	+
To design semi-natural breeding experiences	+	+

Map legend

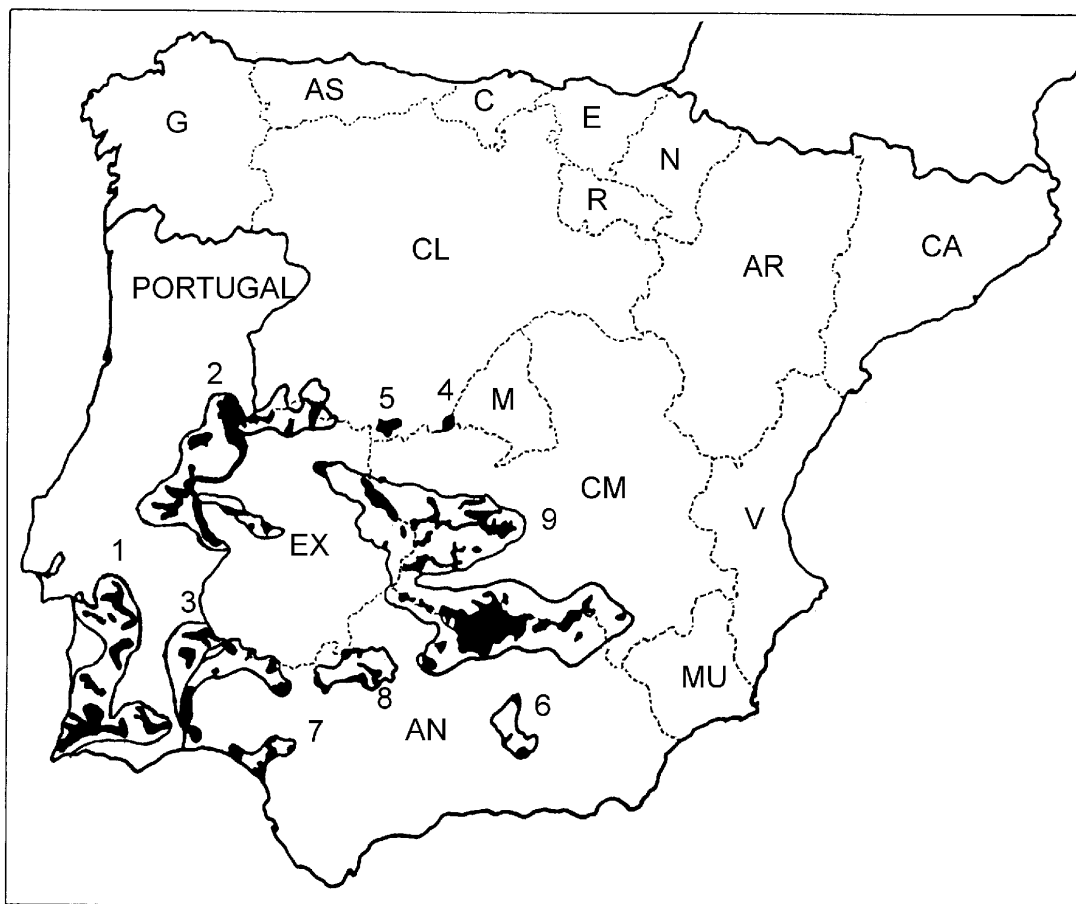


Figure 1: Recent distribution of *Lynx pardinus* in Europe. Data correspond to the latest comprehensive country-wide survey for each country (the eighties in Spain and 1994 -96 in Portugal). Black solid areas represent local populations, i.e. continuous areas of stable presence of the species. Black lines encompassing some of these areas represent metapopulations, i.e. groups of discrete local populations connected through dispersing individuals, more or less isolated among them. Numbers identify each metapopulation described in Table 1; 1: Algarve-Odemira-Sado Valley, 2: Gata-Malcata-S.Pedro-S.Mamede, 3: W.Sierra Morena-Guadiana, 4: Alberche, 5: Gredos, 6: Subbéticas, 7: Doñana, 8: Central Sierra Morena, 9: Central Population (E.S.Morena-Montes de Toledo-Villuercas). For Spain, dotted lines represent boundaries between administrative regions, identified by letters as follows: G = Galicia; AS = Asturias; C = Cantabria; E = Euskadi; N = Navarra; AR = Aragón; CA = Cataluña; R = Rioja; CL = Castilla -León; M = Madrid; CM = Castilla - La Mancha; V = Valencia; MU = Murcia; EX = Extremadura; AN = Andalucía.